RECOVERY ENHANCING OF GOLD IN CHALCOPYRITE FLOTATION - CHOICE BETWEEN STANDARD OR NEW REAGENT REGIME

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ABSTRACT

The generaly concept of the new investigated technological schemes and reagent regimes of the flotation concentration process in the Bucim copper mine is based both firstly the demands of the possible complex recovery from useful present minerals or mineral components and secondly increased recovery of incorporated gold.

These laboratory and industrial experiments have enabled to prove the optimal conditions of reagent regimes, the application of new collectors, standard operating and new operating conditions, varied operating conditions etc.

KEY – WORDS: Recovery, gold, silver, standard regime, Orfom, Penflot, varied regime

INTRODUCTION

Bucim copper and gold mine is the unique mine in the Republic of Macedonia located in the southern part of country on the south-west slopes of the Plackovica mountain. The mine is situated 130 km from the Republic capital - Skopje, 13 km from Radovis, and 2.5 km from the road connecting Stip with Strumica.

The unique copper mineralization of a porhiric type is occurring in the gneisses to their contact with the andesites. The mineral content decreases gradually with increasing distance from the contact and occurs principally as fillings and coatings on fracture plans. Andesites are barren in general, however, copper mineralization associated with fractures and joining is found in the andesites as well.

After 1979 the first tones of the copper concentrate are product. Since that time to this day the Bucim mine permanent has realised a good production - financing results including itself in the leader country companies. Mine of the open type is the basis characteristic of the Bucim mine. The mine is equipped with modern mechanisation making possible about the high productivity and good operating conditions for the operators. The process includes drilling and blasting, then blasted ore is transported towards primary crushing while the tailing on the mine disposal. The mineral Processing and ore concentration processes cover the following technological operations: primary, secondary and tertiary crushing, screening and storing, grinding and classification, flotation concentration, regrinding, thickening and filtering and finally the tailing removal in tailing pond.

The technological parameters of the average (1982 - 1994) production of 3,486,036 t/y are followed:

Q	mined ore, t/y	3,486,036
H_2O	(%)	2
Q	treated dry ore, t/y	3,416,315
Cu	Cu content, (%)	0.27
C/Cu	Cu concentrate, t/y	43,878
k/Cu	grade, (%)	18 -20
R/Cu	Cu-recovery, (%)	88
T	tailing, t/y	3,372,438
t/Cu	Cu in tailing, (%)	0.03
R/Au	Au - recovery, (%)	60
R/Ag	Ag - recovery, (%)	35
k/Au	Au in concentrate, g/t	21
k/Ag	Ag in concentrate, g/t	25
Tp	available time, h/y	8,760
Tef	effective time, h/y	7,270
Tb	effective time, (%)	83

LABORATORY INVESTIGATIONS OF THE COPPER SELECTIVE FLOTATION IN THE STANDARD AND NEW OPERATING CONDITIONS

The representative samples from the Bucim mine were with the average Cu - contend from 0.33 - 0.36 %. The laboratory scale tests from the selective

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copper flotation were made for the copper mineral chalcopyrite with present gold and silver, depending on different reagent regimes and the reagents consumption using the same conditions to determine the optimal conditions for recovery in rougher selective concentrate.

Table 1.

Test	GRINDING	CONDITIONING
N°	Collector (g/t)	Collector (g/t)
1	KEX:KBX=1:1	NaIPX
2	ORFOM-C 0800	NaIPX
3	KEX:KBX=1:1	NaIPX
4	KEX:KBX=1:1	NaIPX
5	ORFOM-C 0800	ORFOM-C 0800
6	PENFLOT-3	PENFLOT-3
7 a	ORFOM-C 0800	NaIPX
b	(PENFLOT-3)	(PENFLOT-3)

Table 1a.

Test	FLOTATION	
N°	Collector (g/t)	Frother (g/t)
1	NaIPX	Dow - 250
2	NaIPX	Dow - 250
3	ORFOM-C 0800	Dow - 250
4	NaIPX 15 g/t	
	ORFOM-C 0800 10 g/t	Dow - 250
5	ORFOM-C 0800	Dow - 250
6	PENFLOT-3	Dow - 250
7 a	NaIPX	Dow - 250
b	(PENFLOT-3)	Dow - 250

Table 2. Results obtained from test N°-1

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.35	0.54	1.10	100	100	100
C	5.19	6.80	7.60	90.8	77.3	41.4
T	0.03	0.13	0.70	9.2	22.7	58.6
∑	0.35	0.54	1.10	100	100	100

Table 3. Results obtained from test N°-2

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.35	0.40	1.13	100	100	100
C	5.01	5.40	7.60	90.4	85.8	42.2
T	0.04	0.06	0.70	9.6	14.2	57.8
∑	0.35	0.40	1.13	100	100	100

Table 4. Results obtained from test N°-3

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.33	0.34	1.12	100	100	100
C	4.72	4.40	7.40	89.8	80.8	41.4
T	0.04	0.07	0.70	10.3	9.2	58.6
∑	0.33	0.34	1.12	100	100	100

Table 5. Results obtained from test N°-4

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.33	0.52	1.11	100	100	100
C	4.85	5.70	7.40	90.2	80.7	41.2
T	0.03	0.09	0.70	9.8	9.3	58.8
∑	0.33	0.52	1.11	100	100	100

Table 6. Results obtained from test N°-5

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.36	0.51	1.09	100	100	100
C	3.94	5.20	5.90	91.2	82.6	45.4
T	0.03	0.10	0.65	8.8	17.4	54.7
∑	0.36	0.51	1.09	100	100	100

Table 7. Results obtained from test N°-6

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.33	0.50	1.10	100	100	100
C	3.57	4.70	6.00	89.7	77.9	45.4
T	0.04	0.12	0.65	10.3	22.1	54.6
∑	0.33	0.50	1.10	100	100	100

Table 8. Results obtained from test N°-7a (rougher + 2 cleaning)

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.34	0.45	1.13	100	100	100
C	18.8	20.2	21.2	76.2	63.2	26.3
m 1	4.20	9.20	9.00	10.3	17.5	6.8
m 2	0.38	0.60	2.80	3.9	4.8	8.5
T	0.03	0.07	0.70	9.56	14.5	58.4

Table 9. Results obtained from test N°-7b (rougher + 2 cleaning)

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.35	0.62	1.08	100	100	100
C	16.9	22.8	19.0	72.4	55.8	26.8
m 1	2.88	10.3	6.30	10.7	22.0	7.8
m 2	0.44	0.55	2.10	6.1	4.4	9.7
T	0.04	0.12	0.65	10.8	17.8	55.7

INDUSTRIAL SCALE INVESTIGATIONS OF THE COPPER SELECTIVE FLOTATION IN THE STANDARD AND NEW OPERATING CONDITIONS

The one month copper ore twice from the Bucim mine was treated industrial by selective scheme of flotation by aim to recovery chalcopyrite and present gold and silver, depending on different reagent regimes (standard: KEX:KBX or NaIPX).

The results obtained by these investigations are given on the followings tables with contemporary industrial technological indicators.

Table 10. Results obtained from selective Cu flotation at reagent regime: standard

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.28	0.38	1.12	100	100	100
C	19.7	14.2	24.5	87.5	55.0	29.3
T	0.04	0.18	0.80	12.5	45.0	70.7
∑	0.29	0.38	1.12	100	100	100

Note: 128,000 t

Table 11. Results obtained from selective Cu flotation at reagent regime: new

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.27	0.39	1.10	100	100	100
C	20.8	16.0	27.5	88.7	63.5	33.8
T	0.03	0.14	0.74	11.3	36.5	66.2
∑	0.27	0.39	1.10	100	100	100

Note: 128,000 t

Table 12. Results obtained from selective Cu flotation at reagent regime: standard

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.25	0.49	1.15	100	100	100
C	18.5	21.1	25.2	86.0	58.0	30.5
T	0.03	0.21	0.81	14.0	42.0	69.5
∑	0.25	0.49	1.15	100	100	100

Note: 235,000 t

Table 13. Results obtained from selective Cu flotation at reagent regime: new

	Grade (%) or g/t			Recovery (%)		
	Cu	Au	Ag	Cu	Au	Ag
Feed	0.25	0.48	1.17	100	100	100
C	19.3	23.2	26.1	87.5	64.3	35.2
T	0.03	0.17	0.77	12.5	35.7	64.8
∑	0.25	0.48	1.17	100	100	100

Note: 235,000 t

CONCLUSION

In spite of relatively low grade mined ore over the both intensive laboratory scale and industrial technological investigations ore obtained a fairly good results achieving the significant copper recovery and significant improved gold and silver extraction.

Varied ratio of different applied collectors in the grinding, conditioning and flotation circuit gives the following optimal laboratory scale results:

Conditions	Recovery (%)		
	Cu	Au	Ag
Standard	90.85	77.27	41.36
New-Orfom C0800	91.18	82.66	45.43
New-Penflot - 3	92.50	77.26	48.71
Varied	90.35	85.82	42.20

Contemporary parallel industrial scale investi-gations give the following optimal results:

Conditions	Recovery (%)		
	Cu	Au	Ag
Standard	87.50	55.02	29.30
New	87.50	64.25	35.20

The evident disproportional between laboratory scale results and industrial scale results are appeared on the Au and Ag recoveries. Firstly, the treated ore in the laboratory scale tests is richer (0.33 - 0.36 % Cu) than treated ore in the industrial scale tests (0.246 - 0.285% Cu). It may be explained because of unpleasant and sharp smell (ORFOM - C 0800 and PENFLOT - 3) in the flotation plant. For that reason the collector producer must remove this unpleasant appearance.

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